Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S

Canadian Science Advisory Secretariat

Research Document 2007/006

Not to be cited without permission of the authors *

S C C S

Secrétariat canadien de consultation scientifique

Document de recherche 2007/006

Ne pas citer sans l'autorisation des auteurs *

Trends in Groundfish Bottom Trawl Fishing Activity in BC

Tendances relatives aux activités de pêche au chalut de fond en C.-B

Alan Sinclair

Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, BC V9T 6N7

* This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

* La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Research documents are produced in the official language in which they are provided to the Secretariat.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

This document is available on the Internet at:

Ce document est disponible sur l'Internet à:

http://www.dfo-mpo.gc.ca/csas/

ISSN 1499-3848 (Printed / Imprimé)
© Her Majesty the Queen in Right of Canada, 2007
© Sa Majesté la Reine du Chef du Canada, 2007

Canada

2007-03796/

Abstract

Changes in the spatial extent of the BC groundfish bottom trawl fishery were estimated using fishery observer data. The time period 1996-2005 was chosen for detailed analysis since this is the period for which suitable detailed catch and effort data are available from fishery observers. Tow locations were represented by a vector between the start and end points of the tow. Areal estimates were based on a relatively fine spatial grid of 1 km^2. The implications of these choices on the results of the analysis are discussed. There was virtually no groundfish bottom trawl fishing effort reported from depths greater than 500 m prior to 1990. There has been an extension of the fishery into this depth zone since then. The largest expansion in area fished in the 1996-2005 period was in deep water (>500m) where the longspine thornyhead fishery has developed. There was a considerable increment in cumulative area fished in 2000, the year the longspine thornyhead fishery expanded to northern waters in Triangle (5AB) and Rennell Sound (5E). A second area of expanded fishing is northeast of Middle Bank. This area yielded the majority of reported catches of species associated with corals and sponges. The annual area fished in 0-150 and 150-500 m coastwide either declined or was stable. There was a considerable reduction in the annual area fished in area 5CD in the 0-150 m depth range. There remain considerable areas that have not been trawled since 1996. These are dominated by rough bottoms not suitable for trawling. There are hook and line and trap fisheries in these areas. Little is known about the habitat forming biota in these areas, species compositions, and demographic profiles of the inhabitants.

Résumé

Les changements de l'étendue spatiale de la pêche du poisson de fond au chalut de fond en C.-B. ont été estimés à l'aide des données des observateurs de la pêche. La période de 1996 à 2005 a été choisie pour l'analyse détaillée, puisqu'il s'agit de la période pour laquelle des données détaillées appropriées sur les prises et l'effort sont disponibles grâce aux observateurs de la pêche. Les emplacements des traits ont été représentés par un vecteur entre les points de départ et de fin du trait. Le calcul approximatif de la superficie a été basé sur une grille relativement fine de 1 km^2. Les répercussions de ces choix sur les résultats de l'analyse sont expliquées. Il n'y avait à peu près aucun effort de pêche au chalut de fond déclaré à des profondeurs de plus de 500 m avant 1990. Depuis lors, il semble y avoir eu une expansion de la pêche dans cette couche de profondeur. La plus grande expansion de la zone exploitée au cours de la période de 1996 à 2005 a été vers la profondeur (>500 m) où la pêche du sébastolobe à longues épines a été entreprise. On constate une augmentation considérable de la zone cumulative pêchée en 2000, année où la pêche du sébastolobe à longues épines a été étendue vers les eaux du nord dans le Triangle (5AB) et la baie Rennell (5E). Le nord-est du Banc du Milieu est une deuxième zone où la pêche s'est élargie. Cette zone a donné la plupart des prises déclarées d'espèces associées aux récifs de coraux et d'éponges. La superficie annuelle exploitée entre 0 et 150 m et entre 150 et 500 m, à l'échelle de la côte, a diminué ou est demeurée stable. On a noté une réduction considérable de la superficie annuelle exploitée dans la zone 5CD, dans l'échelle de profondeur de 0 à 150 m. Il reste des zones considérables où il n'y a pas eu de chalutage depuis 1996; elles se caractérisent par des fonds accidentés qui ne se prêtent pas au chalutage. Des pêches aux lignes et aux casiers y sont pratiquées. On connaît très peu le biote des biohermes de ces zones, la composition des espèces et les profils démographique de leurs habitants.

1 Introduction

Fishing will impact the organisms sought by the fishery, organisms taken as incidental catch, and the gear may also physically impact organisms and structures that form habitat used by both targeted species and those cohabitating the area fished. There is growing interest in the Pacific Region and worldwide in gaining a better understanding of impacts of fishing on habitat forming structures. Attention within the Pacific region has recently been focused on fishing impacts on corals and sponges as indicated by the formation of the Pacific Coral and Sponge Conservation Strategy Working Group.

Bottom trawls are designed to catch fish while riding along the sea floor. The sea floor is contacted by the trawl doors, bridles, foot gear, and trawl meshes. It is known that trawling can impact habitat forming materials, be they inanimate or living.

The Oceans, Habitat, and Enhancement Branch has requested an analysis of changes in the extent of groundfish bottom trawling on the BC coast as background information for the Pacific Coral and Sponge Conservation Strategy Working Group. A Request for Working Paper was prepared (Appendix 1) with the following objectives:

1) Identify and analyse temporal trends in the areal extent and depth of fishing activity by bottom trawl, during the period for which geographic data is recorded for trawl sets.

2) Identify, temporally and spatially, those areas of the continental shelf and slope, and abyssal depths that are being targeted by bottom trawl fisheries.

3) Identify those emerging bottom trawl fisheries that are moving into heretofore un-fished habitats.

4) Comment on what these trends suggest in terms of the urgency of implementing measures to mitigate impacts to benthic habitats such as corals and sponges.

There were also 2 questions

1) Are areas bottom trawled stable over time, or is the bottom trawl activity expanding in area or going into new areas or depths?

2) Are any new areas being fished since 2000 experiencing coral and sponge bycatch levels?

The general approach used in the analysis is to map the annual spatial extent of the groundfish bottom trawl fishery and estimate both the annual area covered and to identify new areas fished each year. The time period 1996-2005 was chosen for detailed analysis since this is the period for which suitable detailed catch and effort data are

available from fishery observers.

2 Methods

A 100% observer coverage program was introduced on large groundfish vessels using bottom trawls fishing in areas 3CD5ABCDE in 1996. The database includes detailed tow-by-tow data on fishing activities and catches. As such, it provides an excellent source of data to address the request for working paper. I have also referred to the fishing data from the GFCatch database (Rutherford 1999) to determine the period over which deep water (>500m) fishing occurred off the coast.

2.1 Data Selection

The observer data for groundfish bottom trawl activity since 1996 were obtained from the PacHarvTrawl database, a copy of which is maintained by the groundfish section, Pacific Biological Station, Fisheries and Oceans Canada. The observers record detailed fishing operation and species catch data from each fishing tow. The following criteria were used to select the data:.

year >= 1996
effort > 0
depth > 0 (valid code)
gear = bottom trawl
1 < major area <= 9

2.2 Spatial Representation

All tow location data were converted from longitude and latitude to easting and northing using UTM zone 9. This allowed the use of a uniform spatial grid for calculating the area fished. The easting and northing data were reconverted to longitude and latitude for plotting purposes. The ACON plotting package was used for displaying the results (http://www.mar.dfo-mpo.gc.ca/science/acon/).

There are several options for the display of spatial trawl data. Two main issues were considered here, how to represent the location of the tow, and what resolution of spatial grid to use to calculate the fishery distribution and plot its spatial distribution.

Ideally one would like to unambiguously assign catch and fishing effort to the precise location where it occurred. However, this is not possible since only start and end positions, and more recently an additional third mid-point, of the tows have been recorded. It is also not possible to determine at what location during the tow individual catches were made. Thus, a compromise was needed.

A preliminary analysis was conducted to help decide how to represent the fishery distribution. Two options were used for representing the tow location, 1) with a single point only, in this case the start point, and 2) assuming the tow covered the ground

between the recorded start and end points of the tow. In the latter option, the assumed tow vectors were divided into segments at the intersections of the plotting grid (see Figure 1). Four options were used for grid size, 1 km^2, 4 km^2, 25 km^2, and 100 km^2. For all trials, a grid cell was counted as having been fished ("hit") if there were two or more tow segments in the cell. A threshold of 2 hits was used to eliminate anomalous points caused by data errors.

The results of these trials indicated that using only one location for the tow resulted in lower estimates of the area covered by trawling (Figure 2). This result is expected since many tows span several grid cells, depending of course on the grid cell size used. It would seem that using only one point to represent the tow location would underestimate the area of the fishery. It was also noted that the estimated area fished increased as the grid size increased (Figure 2). The reason is demonstrated in Figure 1. The figure is draw with a 1 km^2 grid. The tow vector 'hits' 5 grid cells and the estimated area of the tow would be 5 km^2. If a 4 km^2 grid was used instead, the tow vector would 'hit' both grid cells and give an estimate of 8 km^2 fished. Based on these observations, it was decided to represent the tow location with a vector between the start and end positions, and to use a grid size of 1 km^2.

2.3 Computations

The BC coast was divided into a 1 km^2 grid. As noted above, a grid cell was counted as having been fished if there were 2 or more 'hits' within it. The spatial grid was further subdivided into fisheries management areas corresponding to the Pacific Fisheries Management Area designations described in Table 1. These areas were combined into four areas corresponding to boundaries commonly used for groundfish stock management, 3CD, 5AB, 5CD, and 5E. The mean depth reported as being fished in all tows across all years in individual grid cells was calculated and used to place the grid cells into three depth zones, 0 m < depth < 150 m, 150 m <= depth < 500 m, depth >= 500 m. This allowed calculations to be done by management area and depth zone.

Results were compiled regarding two quantities, the annual area fished, and the cumulative area fished. The former was informative regarding the total area fished each year. The latter was estimated by tabulating the first year each grid cell was fished, and summing the number of grid cells added each year. The cumulative area fished was presented as both the absolute numbers and the cumulative percentage of the total. The annual increment in cumulative area would represent new fishing areas.

2.4 Relative Change

It is important to note that the estimates of area fished produced under these assumptions will have inherent biases. First of all, as noted above, the choice of how to represent the tow location and the grid size will affect the magnitude of the estimates. Furthermore, no attempt was made to accurately represent the width of the tow track. Consequently, it is recommended that all estimates produced here be treated as relative estimates designed to measure relative changes in the area fished and to identify new

fishing grounds. Secondly, no attempt was made to determine the incremental impact of repeated trawling over the same location. This would require more focused research including new field work.

3 Results

3.1 Changes in Area Fished

On a coastwide basis, there has been a decline in the annual area fished in the 0-150 m and 150-500 m depth ranges over the period 1996-2005 (Table 2, Figure 3). There was an incr ase in the annual area fished in the 500+ m range between 1996 and 2000. The area fished was stable until 2004, then it declined in 2005. The cumulative area fished increased annually in each depth zone. Over 95% of the cumulative area fished was reached by 2001 in all three depth zones. The largest percentage increase occurred in the 500+ m depth range.

The annual area fished was relatively stable in areas 3CD and 5AB for most of the 1996-2005 period (Table 2, Figure 4). There was a slight decline in 2002 to 2005 in both areas. The annual area fished declined considerably in 5CD throughout the time period. The annual area fished in 5E was stable between 1996 and 1999, there was a large increase in 2000, followed by a stable period until 2004, and a decline in 2005. Over 95% of the cumulative area fished was reached by 2001 in all four management areas. The largest increase in the cumulative area fished occurred in 5E.

Within the 0-150 m depth zone, there was a substantial decline in the annual area fished in management area 5CD while this statistic was stable in 3CD and 5AB (Table 3, Figure 5). There was very little area fished in this depth done in 5E and the graphical results are not presented here. The cumulative percentage increase in area fished was similar in 5AB and 5CD, and 95% of the area was fished by 2000 and 1999 respectively (Table 4). There was a larger percentage increase and a more gradual increment in area fished in 3CD and 95% of the area fished was reached in 2003.

Within the 150-500 m depth zone, the annual area fished was relatively stable in 3CD, 5AB, and 5E, while there was a decline in 5CD (Table 3, Figure 6). The lowest percentage increase in cumulative area fished occurred in 3CD, while the rate of change was similar in the other 3 areas. However, there was a large range in dates when 95% of the area fished occurred, 1999 in 3CD, 2001 in 5AB, 2002 in 5CD, and 2000 in 5E (Table 4).

There was an initial increase in the annual area fished in all three management areas within the 500+ m depth zone. This peaked in 3CD in 1999 and in 2000 in 5AB and 5E. These peaks were followed by a stable period until 2004, then a decline in 2005 (Table 3, Figure 7). There was very little area fished in this depth done in 5CD and the graphical results are not presented here. The cumulative percentage increase in area fished was greatest in areas 5AB and 5E, with the largest increase occurring in 2000 (Table 4, Figure 7). 95% of the cumulative area fished occurred in 2000 in 3CD, 2002 in

5AB, and 2001 in 5E.

3.2 Location of Effort Expansion

An analysis of reported fishing effort by depth zone for the period 1954-1995 using data in the GFCatch database revealed that there was virtually no reported fishing effort at depths over 500m prior to 1990. The footprint of the groundfish bottom trawl fishery since 1996 is shown in Figure 8 colour coded for the mean depth reported for each grid cell. Thus, one can conclude that all of the area shown to be over 500 m depth was newly fished since 1990.

This same trawl footprint is shown again in Figure 9 but this time it is colour coded according to the first reported fishing event in the grid cell. The light blue area was fished in 1996-1997. The red area was added in 1998-1999, the yellow area in 2000-2002, and the dark blue area in 2003-2005. The largest new areas in 1998-1999 are shown off the west coast of Vancouver Island between 49° and 50° latitude, in several areas west of the Queen Charlotte Islands, and on the western edge of Middle Bank around 52° latitude. All of these areas with the exception of the western edge of Middle Bank were associated with the developing longspine thornyhead fishery. New area was added in 2000-2002 west of Brookes Peninsula, at Triangle, and off the west coast of the Queen Charlotte Islands. These areas were also associated with the longspine thornyhead fishery and an experimental fisheries plan to distribute fishing effort over a larger area. New area was also added northeast of Middle Bank where yellowtail, redstripe, silvergrey and redbanded rockfish were taken. Very little new area was added in 2003-2005. The largest area was in southern 3CD along the Canada-USA border.

3.3 Sponge and Coral Catches Since 2000

The reported catches of the 6 species groups associated with corals and sponges are given in Table 5. More than 10% of the total catch was reported during 2000-2005 for Sponges, Glass sponges, and Soft corals. It should be noted that observers received additional training on identifying corals and sponges in 1999, and it may also be true that there was an increased catch reporting rates of these species because of the heightened interest in the species. Therefore, it may be misleading to interpret any trends in catches before and after 2000. The locations of these catches were identified as follows.

Three catch locations were identified for Sponges. The majority of the catch, 31.4 t or 88% of the catch since 2000, was taken in an area northeast of Middle Bank (marked as area 1 in Figure 9). There were 2.7 t of Sponge reported from the area west of Brookes Peninsula (Area 2), and 1.12 t reported from the Hogback, west of Rennell Sound (Area 3). Virtually all of the reported catch of Glass sponge since 2000 came from northeast Middle Bank (Area 1). The majority of the post 2000 reported catch of Soft coral came from northeast Middle Bank (Area 1, 10.9 t) with the rest coming from the area west of Banks Island (Area 4).

4 Discussion and Conclusions

To my knowledge, this is the first request for working paper from the Oceans, Habitat and Enhancement Branch that deals specifically with changes in the spatial extent of a commercial fishery. It would have been very difficult to address this Request for the majority of our fisheries because of a paucity of high resolution and reliable fisheries data. The exceptional circumstances of the BC groundfish bottom trawl fishery having 100% coverage by observers who have recorded such high resolution data made this analysis possible.

The choice of how to represent fishing data will have a dramatic effect on absolute estimates of area fished, and by extension on absolute estimates of species distributions. This is clearly shown in Figure 2. If one chose to represent the tow location by the start location and to use a spatial grid of 5 km on a side (25 km^2), the estimated area impacted by trawling would be 30,000 km^2 annually. If, on the other hand, one chose to represent the tow location by a vector between the start and end point and to use a 1 km^2 grid, the estimated area fished would be 19,000 km^2 annually. This observation is of particular interest if commercial fishing data are used to estimate the area of occupancy for COSEWIC status reports.

It was decided to represent the tow location by a vector between the start and end points and to use a relatively fine spatial grid of 1 km^2 for the purposes of this analysis. This seemed appropriate for 2 main reasons. Firstly, using only one point to represent the tow would underestimate the area covered by a considerable amount. While the actual tow track is unlikely to be a straight line, the vector alone would tend to underestimate the actual area impacted. However, I reasoned that this would be the best use of the available information. Secondly, it was clear that using a courser grid resulted necessarily in larger estimates of area fished, within a reasonable spatial scale. Even with these caveats, it is important to note that this analysis dealt specifically with relative changes in area fished. The absolute estimates of area fished will be biased.

There was virtually no groundfish bottom trawl fishing effort reported from depths greater than 500 m prior to 1990. The map of fishing effort by depth zone presented in Figure 8 shows a considerable area greater than 500 m having been fished since 1996. It is thus possible to conclude that this area was newly fished since 1990.

The largest expansion in area fished in the 1996-2005 period was in deep water (>500m), areas where the longspine thornyhead fishery has developed. The estimated area fished in this depth zone was 3100 km2 in 1996, and the cumulative area fished increased to 7300 km2 by 2005. There was a considerable increment in cumulative area fished in 2000, the year the longspine thornyhead fishery expanded to northern waters in Triangle (5AB) and Rennell Sound (5E). This expansion was part of an experimental plan to develop this fishery. A second area of expanded fishing is northeast of Middle Bank (Area 1 in Figure 9). This area yielded the majority of reported catches of species associated with corals and sponges.

The annual area fished in 0-150 and 150-500 m coastwide either declined or was stable. There was a considerable reduction in the annual area fished in area 5CD in the 0-150 m depth range.

This paper addressed the first 3 of the 4 objectives given in the request for working paper. The fourth objective asked me to comment on the urgency of implementing measures to mitigate impacts to benthic habitats such as corals and sponges. I simply do not think it is appropriate for me to express a singular, personal and professional opinion on this question. Rather, I believe it is up to the Coral and Sponge Working Group to use the information presented here and whatever other information they consider relevant to form opinions on what should be done and how urgently action should be taken. As far as I am aware, there is currently no policy on dealing with the effects of fishing on corals and sponges in this Region. There are no benchmarks by which to judge "urgency". I do not think it is my place to suggest anything in this area.

There remain considerable areas that were not trawled in the period 1996-2005. These are dominated by rough bottoms not suitable for trawling. There are hook and line and trap fisheries in these areas. Little is known about the habitat forming biota in these areas, species compositions, and demographic profiles of the inhabitants.

5 Acknowledgements

Chris Grandin was very helpful in programming the conversion to and from latitude and longitude and UTM coordinates, as well as the algorithm to distribute tow data among grid cells along the tow vector.

6 References

Rutherford, K.L. 1999. A brief history of GFCATCH (1954-1995), the groundfish catch and effort database at the Pacific Biological Station. Can. Tech. Rep. Fish. Aqua. Sci. 2299: 66p.

7 Tables

Table 1: Criteria used to classify gridded fishing locations to PFMA management areas.

PFMA	Criteria
3CD	`if latitude <= 50.5`
5AB	`if 50.5 < latitude <= 51.8333 or (51.8333 < latitude <= 52.1667 and -131 < longitude)`
5CD	`if (52.1667 < latitude and -131.1667 < longitude) or (52.3333 < latitude and -131.5 < longitude) or (52.6667 < latitude and -132 < longitude) or (54 < latitude and -133 < longitude)`
5E	`if 51.8333 <= latitude and longitude <= -133 or (latitude <= 54 and longitude <= -132) or (latitude <= 52.6667 and longitude <= -131.5) or (latitude <= 52.3333 and longitude <= -131.1667) or (latitude <= 52.1667 and longitude <= -131)`

Table 2: Tabulation of estimated annual area fished and annual incremental new area fished by depth zone and PFMA management areas. These calculations were based on distribution fishing tows across a 1 km2 grid assuming the tow followed a straight line between the start and end points. These should not be taken as absolute estimates, but rather used to indicate relative differences spatially and over time.

	Annual Area Fished (km2)					Incremental (km2)				
	0-150	150-500	500+		All	0-150	150-500	500+		All
1996	9001	11790	3121		23912	9001	11790	3121		23912
1997	8009	10722	3404		22135	1681	2080	1105		4866
1998	7839	10535	3922		22296	936	1137	646		2719
1999	8353	10131	4346		22830	758	677	850		2285
2000	8442	10672	5476		24590	596	528	1018		2142
2001	7126	10148	5274		22548	264	391	298		953
2002	7166	10121	5496		22783	214	366	163		743
2003	6642	9432	5169		21243	120	157	38		315
2004	6398	9499	4793		20690	79	112	10		201
2005	6040	8743	3205		17988	134	50	3		187
	3CD	5AB	5CD	5E		3CD	5AB	5CD	5E	
1996	7532	7810	6789	1781	23912	7532	7810	6789	1781	23912
1997	7210	7613	5976	1336	22135	1775	1624	1177	290	4866
1998	7456	7156	6006	1678	22296	971	715	647	386	2719
1999	8548	7170	5770	1342	22830	1084	572	386	243	2285
2000	8599	8041	5600	2350	24590	682	642	255	563	2142
2001	8245	7332	4693	2278	22548	230	319	218	186	953
2002	8741	7725	4333	1984	22783	189	277	192	85	743
2003	7962	7362	3899	2020	21243	88	129	57	41	315
2004	7928	6904	3682	2176	20690	66	59	69	7	201
2005	7158	6267	3120	1443	17988	127	50	9	1	187

Table 3: Tabulation of estimated annual area fished by depth zone within PFMA management areas. Please note caveats about these estimates in the text and caption for Table 2.

		Annual Area Fished (km2)			
Area	Year	0-150	150-500	500+	All
3CD	1996	2246	2963	2323	7532
3CD	1997	1680	2675	2855	7210
3CD	1998	1607	2611	3238	7456
3CD	1999	2072	2832	3644	8548
3CD	2000	2297	2756	3546	8599
3CD	2001	1963	2828	3454	8245
3CD	2002	2222	2762	3757	8741
3CD	2003	1953	2565	3444	7962
3CD	2004	2053	2522	3353	7928
3CD	2005	2067	2592	2499	7158
5AB	1996	2671	4831	308	7810
5AB	1997	2486	4805	322	7613
5AB	1998	2486	4479	191	7156
5AB	1999	2506	4562	102	7170
5AB	2000	2528	4874	639	8041
5AB	2001	2358	4446	528	7332
5AB	2002	2457	4612	656	7725
5AB	2003	2399	4366	597	7362
5AB	2004	2205	4330	369	6904
5AB	2005	2108	4128	31	6267
5CD	1996	4077	2712		6789
5CD	1997	3843	2133		5976
5CD	1998	3746	2260		6006
5CD	1999	3775	1995		5770
5CD	2000	3615	1985		5600
5CD	2001	2805	1888		4693
5CD	2002	2486	1847		4333
5CD	2003	2290	1609		3899
5CD	2004	2139	1543		3682
5CD	2005	1865	1255		3120
5E	1996	7	1284	490	1781
5E	1997		1109	227	1336
5E	1998		1185	493	1678
5E	1999		742	600	1342
5E	2000	2	1057	1291	2350
5E	2001		986	1292	2278
5E	2002	1	900	1083	1984
5E	2003		892	1128	2020
5E	2004	1	1104	1071	2176
5E	2005		768	675	1443

Table 4: Tabulation of estimated incremental new area fished by depth zone within PFMA management areas. Please note caveats about these estimates in the text and caption for Table 2.

		Incremental Area Fished			
Area	Year	0-150	150-500	500+	All
3CD	1996	2246	2963	2323	7532
3CD	1997	537	344	894	1775
3CD	1998	344	182	445	971
3CD	1999	327	125	632	1084
3CD	2000	356	68	258	682
3CD	2001	113	43	74	230
3CD	2002	140	14	35	189
3CD	2003	67	11	10	88
3CD	2004	55	5	6	66
3CD	2005	120	7		127
5AB	1996	2671	4831	308	7810
5AB	1997	414	1096	114	1624
5AB	1998	276	424	15	715
5AB	1999	202	369	1	572
5AB	2000	155	213	274	642
5AB	2001	87	150	82	319
5AB	2002	56	147	74	277
5AB	2003	36	93		129
5AB	2004	7	52		59
5AB	2005	14	33	3	50
5CD	1996	4077	2712		6789
5CD	1997	730	447		1177
5CD	1998	316	331		647
5CD	1999	229	157		386
5CD	2000	83	172		255
5CD	2001	64	154		218
5CD	2002	17	175		192
5CD	2003	17	40		57
5CD	2004	17	52		69
5CD	2005		9		9
5E	1996	7	1284	490	1781
5E	1997		193	97	290
5E	1998		200	186	386
5E	1999		26	217	243
5E	2000	2	75	486	563
5E	2001		44	142	186
5E	2002	1	30	54	85
5E	2003		13	28	41
5E	2004		3	4	7
5E	2005		1		1

Table 5: Reported catches (upper table – tonnage; lower - % of catch during period covered) of the six species associated with corals and sponges in the BC groundfish trawl fishery broken down by the year the catch location was first fished between 1996-2005.

Year First Fished	Sponges 2A0	Calcareous sponges 2A1	Glass sponges 2I0	Stony corals 3J2	Soft corals 3R0	Gorgonian corals 3S0
1996	71.882	2.689	5.402	33.661	18.577	3.426
1997	54.773	9.421	1.209	14.441	7.631	0.574
1998	2.902	0.093	0.290	2.570	0.839	1.021
1999	15.353	0.075	0.610	10.744	0.863	0.437
2000	17.825	0.138	0.496	0.808	0.378	0.186
2001	18.034	0.008	3.491	0.229	13.251	0.061
2002	4.274	0.018	0.048	0.071	0.358	0.191
2003	0.335	0.002	0.044	0.001	0.011	0.046
2004	3.661	0.000	0.514	0.000	0.005	0.004
2005	0.031	0.000	0.001	0.001	0.000	0.001
Total	189.07	12.44	12.11	62.52	41.91	5.95

	Sponges	Calcareous sponges	Glass sponges	Stony corals	Soft corals	Gorgonian corals
1996	38%	22%	45%	54%	44%	58%
1997	29%	76%	10%	23%	18%	10%
1998	2%	1%	2%	4%	2%	17%
1999	8%	1%	5%	17%	2%	7%
2000	9%	1%	4%	1%	1%	3%
2001	10%	0%	29%	0%	32%	1%
2002	2%	0%	0%	0%	1%	3%
2003	0%	0%	0%	0%	0%	1%
2004	2%	0%	4%	0%	0%	0%
2005	0%	0%	0%	0%	0%	0%
% Since 2000	23%	1%	38%	2%	33%	8%

8 Figures

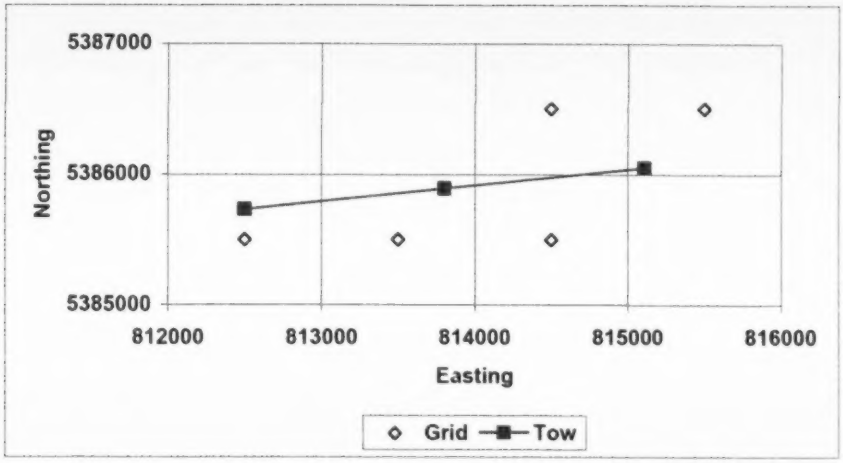

Figure 1: Visualization of how the individual fishing events were spread among grid cells. The pink line represents the tow vector, drawn between the start and end points. The diamonds indicate the grid cells 'hit' by the tow vector.

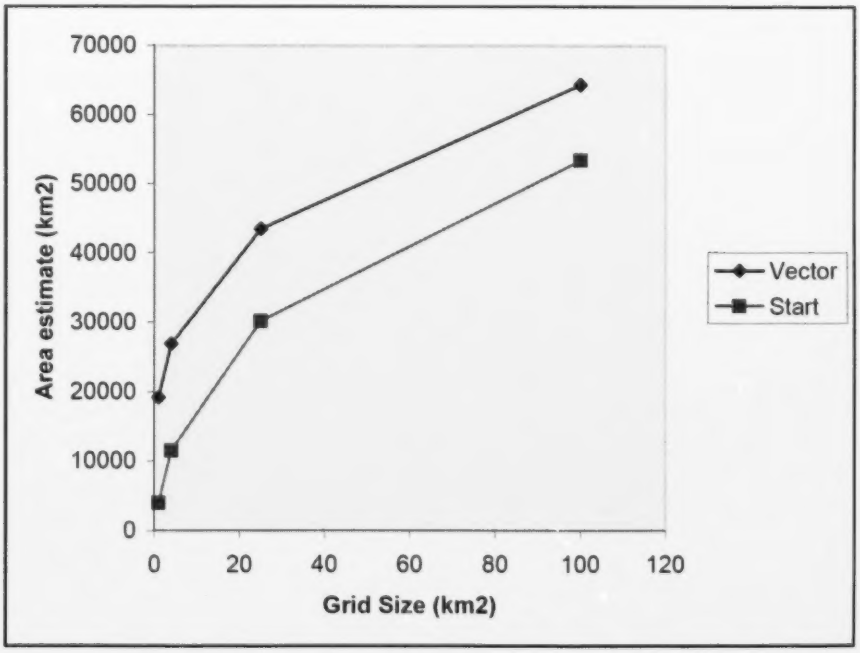

Figure 2: Estimates of mean annual area fished (km^2) in the BC groundfish bottom trawl fishery using 4 grid sizes (1, 4, 25, and 100 km^2) and 2 methods of representing the tow location (tow vector and start point).

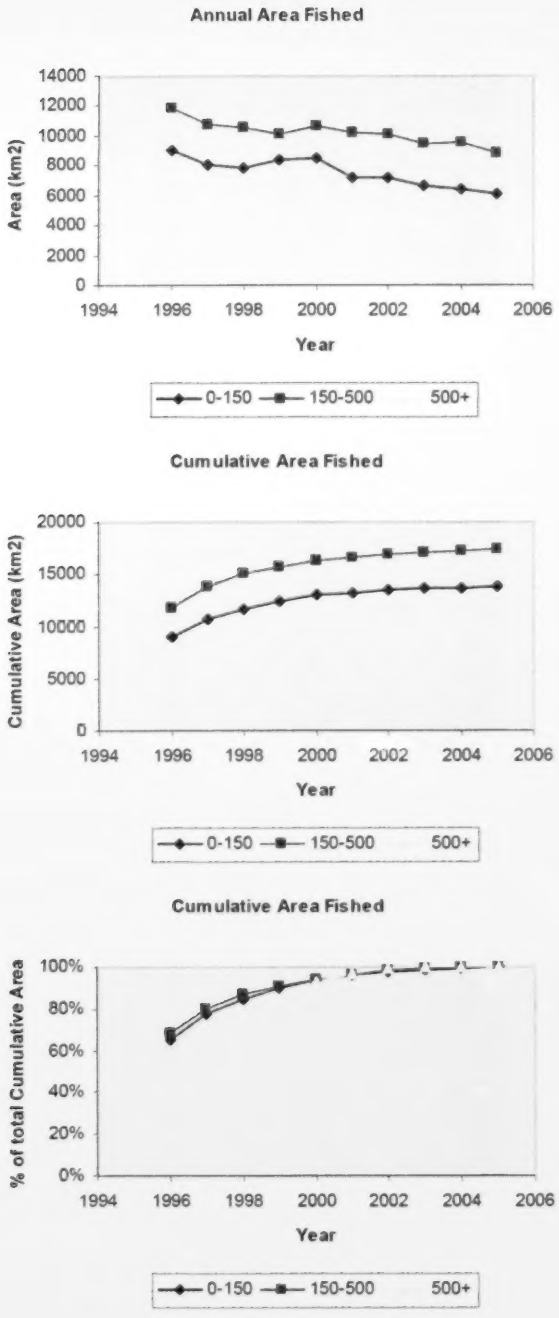

Figure 3: Estimates of relative annual area fished, incremental area fished, and a cumulative percentage of area fished for the BC groundfish bottom trawl fishery in 3 depth zones.

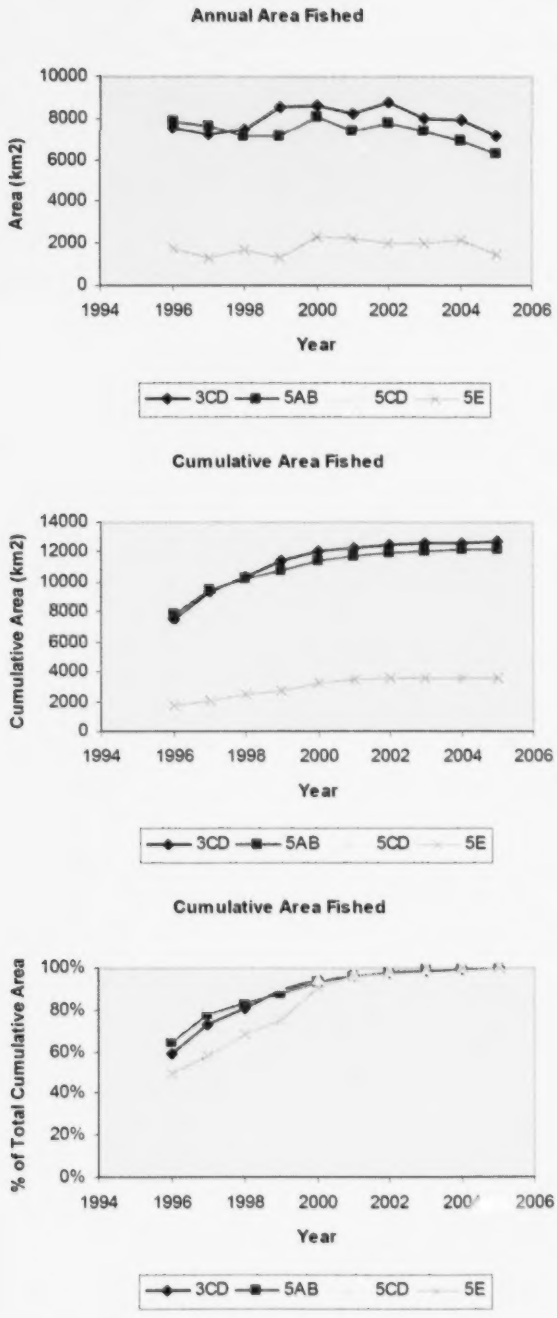

Figure 4: Estimates of relative annual area fished, incremental area fished, and a cumulative percentage of area fished for the BC groundfish bottom trawl fishery in 4 PFMA management areas.

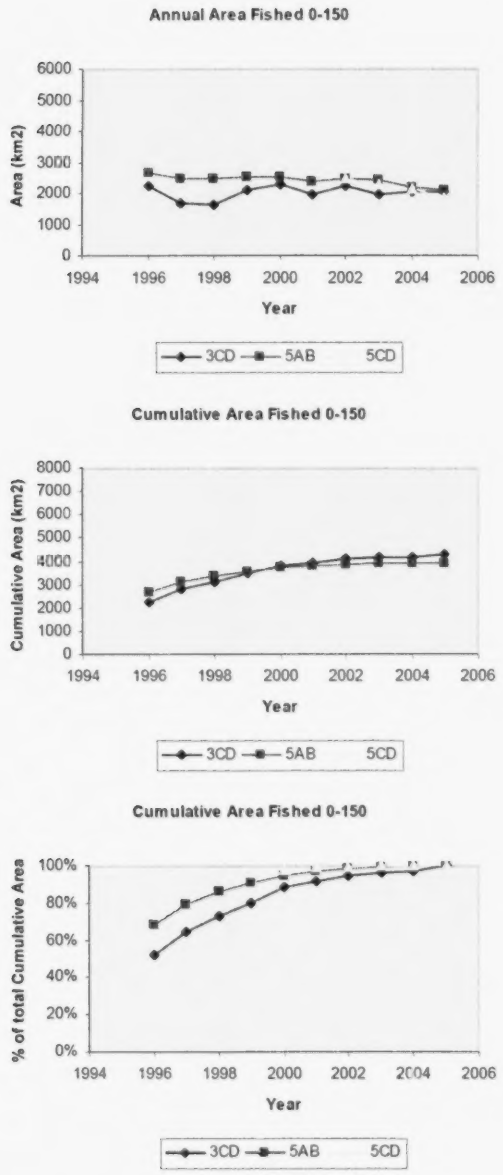

Figure 5: Estimates of relative annual area fished, incremental area fished, and a cumulative percentage of area fished for the BC groundfish bottom trawl fishery in the 0-150 m depth zones and within 3 management areas. Values for 5E were too small to graph.

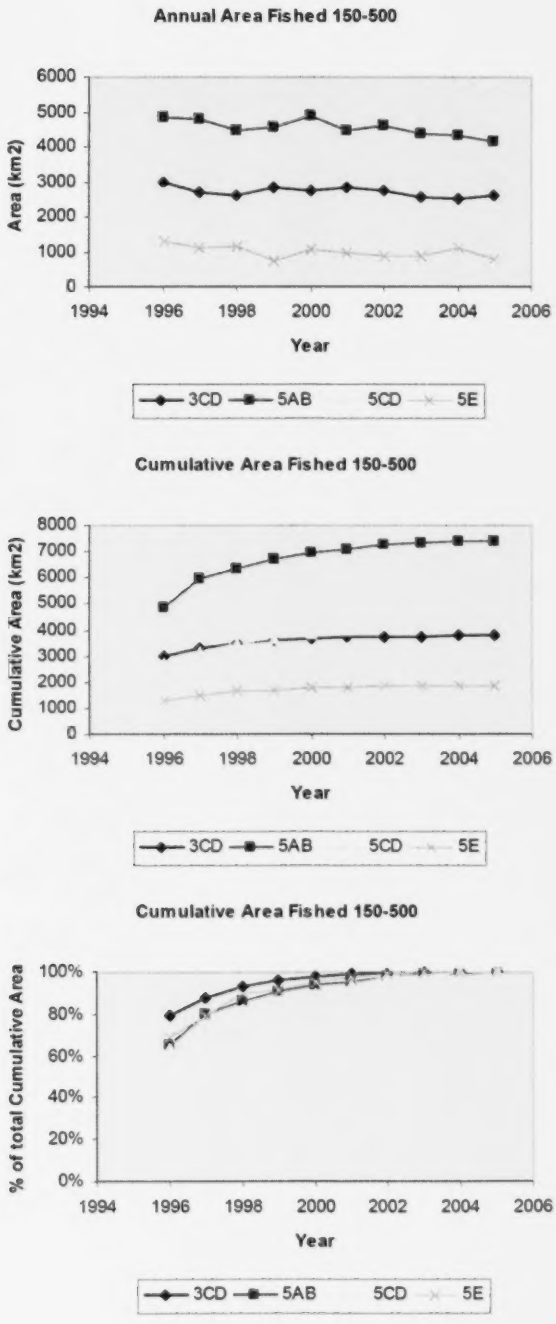

Figure 6: Estimates of relative annual area fished, incremental area fished, and a cumulative percentage of area fished for the BC groundfish bottom trawl fishery in the 150-500 m depth zones and within 4 management areas.

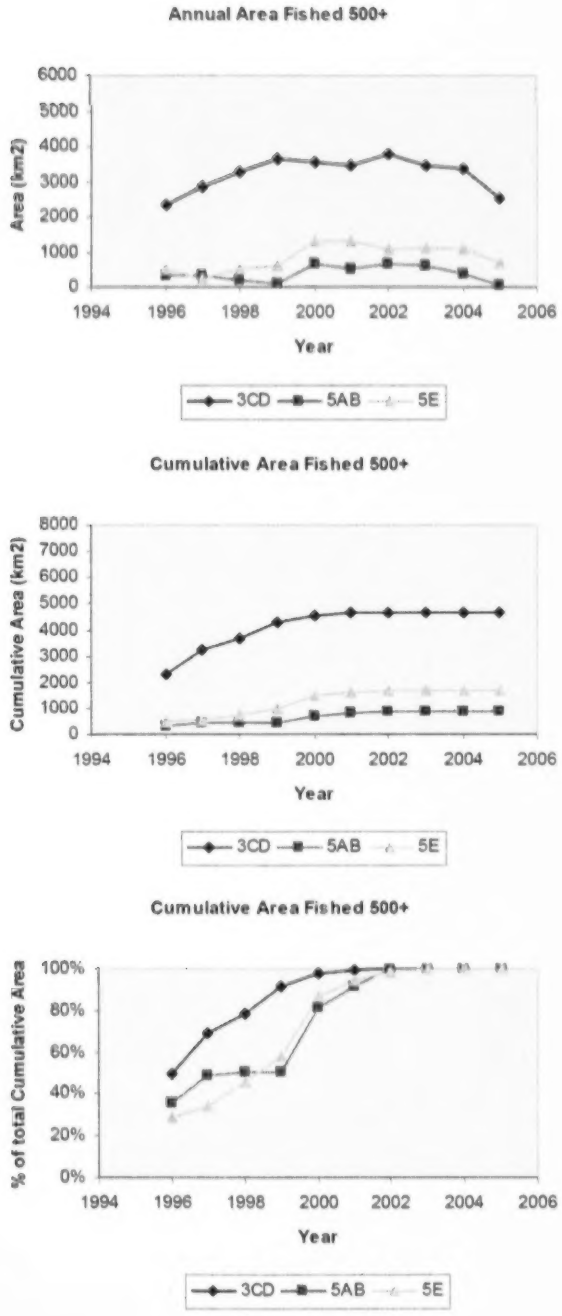

Figure 7: Estimates of relative annual area fished, incremental area fished, and a cumulative percentage of area fished for the BC groundfish bottom trawl fishery in the 500+ m depth zones and within 3 management areas. Values for 5CD were too slamm to graph.

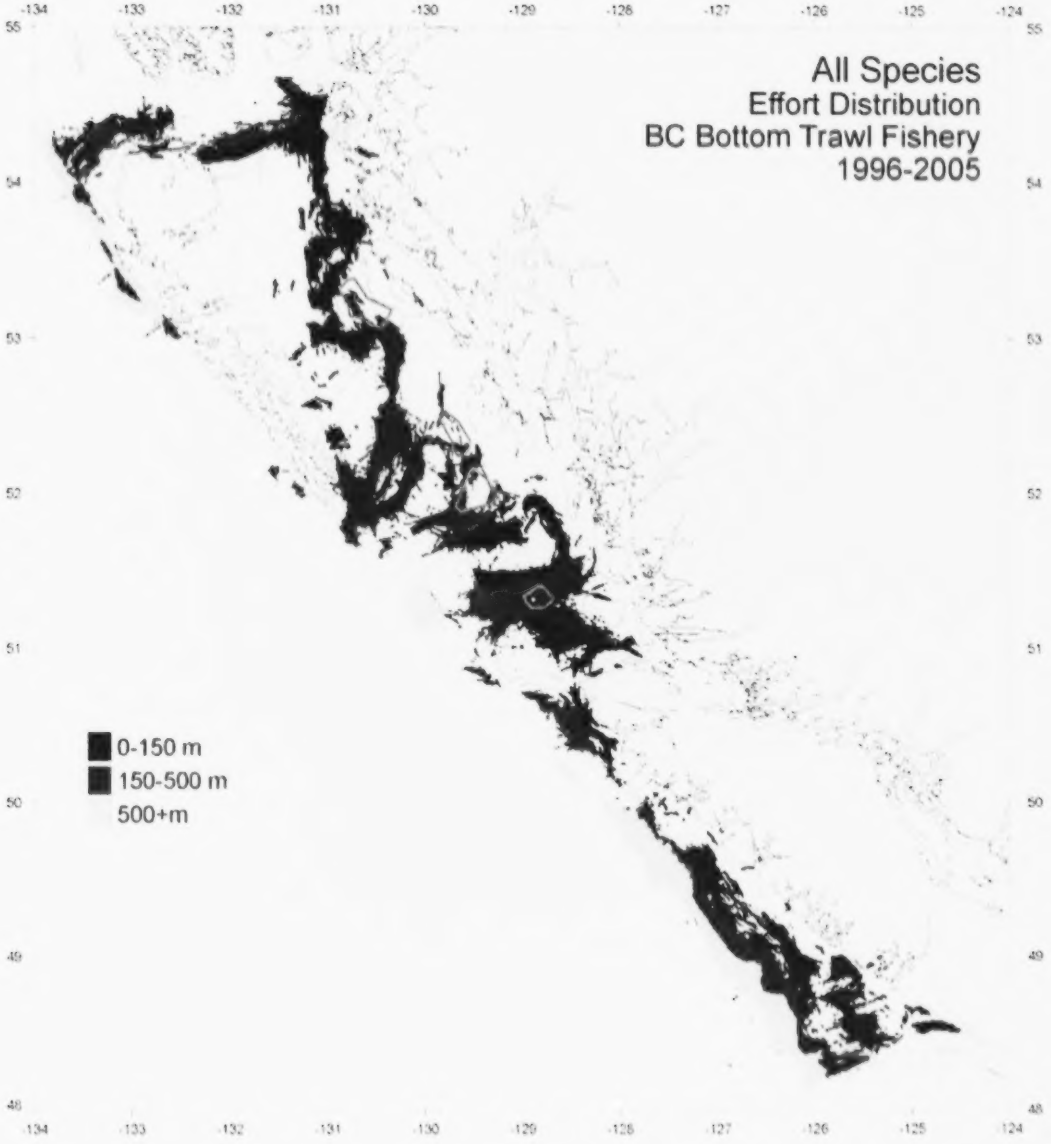

Figure 8: The 1996-2005 footprint of the BC groundfish bottom trawl fishery colour coded to indicate the 3 depth zones used in this analysis. The sponge reef closures in place in 2006/07 are outlined in green.

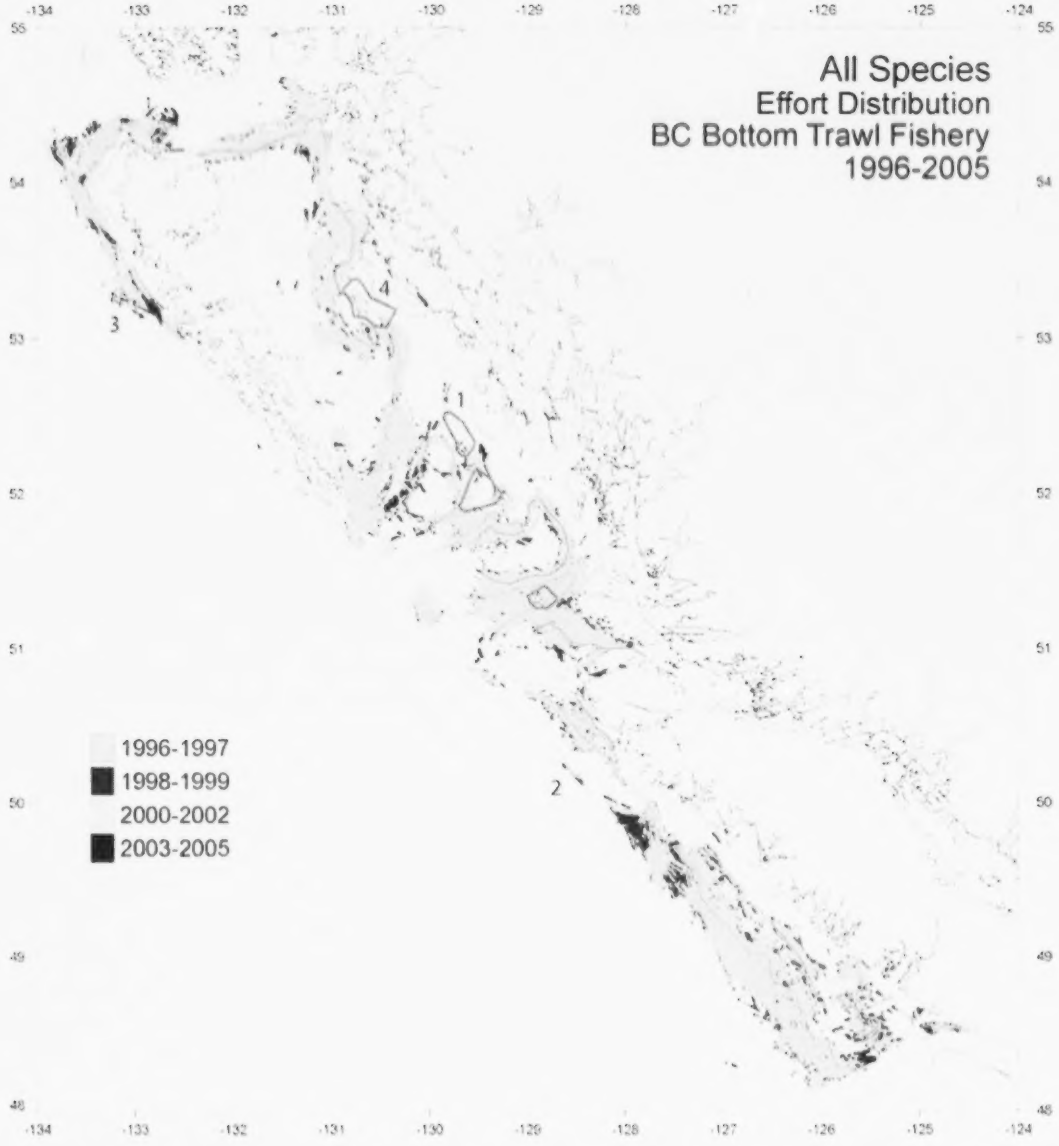

Figure 9: The 1996-2005 footprint of the BC groundfish bottom trawl fishery colour coded to indicate when new area was added. Four time periods were used, 1996-1997, 1998-1999, 2000-2002, and 2003-2005. Four areas referred to in section 3.3 are also indicated. The sponge reef closures in place in 2006/07 are outlined in green.

Appendix 1: PSARC Request for Working Paper[1]

Date Submitted: April 2006

Regional sector requesting advice: Oceans, Habitat, and Enhancement Branch

Proposed PSARC Presentation Date: Fall 2006

Subject of paper (title if developed):
To determine trends in bottom trawl fishing activity in the Pacific Region.

Science lead author: Alan Sinclair, Groundfish Unit, Science Branch

Management lead author: Oceans = Kevin Conley, South Coast Division, OHEB

Rationale for request:
Concern from the public and ENGO community is mounting regarding conservation of habitat forming structural organisms, particularly corals and sponges, in the Pacific Region. One of the major threats to corals and sponges has been identified as bottom trawl fishing. There is concern that bottom trawling is expanding into areas not heavily fished before, and that there is a possibility that in these areas coral and sponge habitat will be destroyed before their importance to fishery production and marine ecosystem health are understood. Therefore the Regional Director General has directed that a Pacific conservation strategy be developed concerning corals and sponges, and to this end a 'Pacific Coral and Sponge Conservation Strategy Working Group was formed. The working group recommended that one of the first steps is to understand the current extent of bottom trawling and the trend of bottom trawling from 1996 to 2005. While necessary scientific reviews of existing information are conducted to provide a context for a coral and sponge conservation strategy, it is critical to determine how immediate the threat is currently from bottom trawling activity, as there may be requirements for more urgent actions to address coral and sponge conservation.

Objective of working paper including assessment of environment/climate impacts:

1) Identify and analyse temporal trends in the areal extent and depth of fishing activity by bottom trawl, during the period for which geographic data is recorded for trawl sets.

2) Identify, temporally and spatially, those areas of the continental shelf and slope, and abyssal depths that are being targeted by bottom trawl fisheries.

3) Identify those emerging bottom trawl fisheries that are moving into heretofore un-fished habitats.

---

[1] Science – append approved RFWP to working paper.
Sector initiator – send approved RFWP to PSARC after sign off, and before significant work begins on the paper.

4) Comment on what these trends suggest in terms of the urgency of implementing measures to mitigate impacts to benthic habitats such as corals and sponges.

Question(s) to be addressed in the working paper:

1) Are areas bottom trawled stable over time, or is the bottom trawl activity expanding in area or going into new areas or depths?
2) Are any new areas being fished since 2000 experiencing coral and sponge bycatch levels?

Stakeholders affected:

Fishing industry (groundfish and shrimp trawl); ENGOs; and research community.

How advice may impact the development of a fishing/recovery plan:

This advice will provide context for the urgency of instituting management measures to protect corals and sponges, in advance of developing a sponge and coral conservation strategy for the Pacific Region.

Timing issues related to when advice is necessary:

Bottom trawling activity continues to occur with coral and sponge bycatch. Continued impacts to these habitat-forming structural organisms may have consequences for ecosystem health and function. This in turn may have ramifications for the long-term stability and success of the fishing industry.

Initiating sector approval:

Regional Director/Designated Authority: _____

Date:_____